

## Comparison of Yoga versus Physical Exercise on Executive Function, Attention, and Working Memory in Adolescent Schoolchildren: A Randomized Controlled Trial

### Abstract

**Purpose:** Executive function, attention, and memory are an important indicator of cognitive health in children. In this study, we analyze the effect of yoga and physical exercise on executive functioning, attention, and memory. **Methods:** In this prospective two-armed randomized controlled trial, around 802 students from ten schools across four districts were randomized to receive daily 1 h yoga training ( $n = 411$ ) or physical exercise ( $n = 391$ ) for 2 months. Executive function, attention, and memory were studied using Trail Making Test (TMT). Yoga ( $n = 377$ ) and physical exercise ( $n = 371$ ) students contributed data to the analyses. The data were analyzed using intention-to-treat approach using Student's  $t$ -test. **Results:** There was a significant increase in numerical TMT (TMTN) values within yoga ( $t = -2.17$ ;  $P < 0.03$ ) and physical activity (PA) ( $t = -3.37$ ;  $P < 0.001$ ) groups following interventional period. However, there was no significant change in TMTN between yoga and PA groups ( $t = 0.44$ ;  $P = 0.66$ ). There was a significant increase in alphabetical TMT (TMTA) values within yoga ( $t = 6.21$ ;  $P < 0.00$ ) and PA groups ( $t = 1.19$ ;  $P < 0.234$ ) following interventional period. However, there was no significant change in TMTA between yoga and PA groups ( $t = 3.46$ ;  $P = 0.001$ ). **Conclusion:** The results suggest that yoga improves executive function, attention, and working memory as effectively as physical exercise intervention in adolescent schoolchildren.

**Keywords:** Adolescents, attention, executive function, physical exercise, yoga

### Introduction

Executive function, attention, and memory are an important indicator of cognitive health in children. Preliminary studies have shown yoga to improve measures of attention and cognition in a small sample of schoolchildren. Yoga is a form of mind–body fitness that involves a combination of muscular activity and an internally directed mindful focus on awareness of the self, breath, and energy.<sup>[1]</sup> It aims at developing an integrated personality, where the growth of physical, mental, social, and spiritual planes is equally focused.<sup>[2]</sup> The advantage of yoga is that its benefits are available to students of all school-age groups. An integrated approach to yoga is necessary for the holistic development of memory,<sup>[3]</sup> attention, executive functioning, and cognitive processing speed.<sup>[4]</sup> Few studies that have directly compared the effects of participating in school-based yoga versus physical education have generally found positive effects of yoga.<sup>[5]</sup> Few studies have

found that yoga is as effective as physical activity (PA) in improving cognitive performance and emotional and behavioral functioning. However, there are no studies that have compared yoga to a structured PA program in a large-scale student population. In this study, we have analyzed the effects of a structured yoga program with structured physical therapy on the measures of attention, information processing, mental speed, and working memory in adolescent high schoolchildren. Our study differs from the other related studies for the fact that our sample size is comparatively huge and the risk of bias due to smaller sample size is low.

In this prospective two-armed randomized controlled trial, around 802 students from ten schools across four districts were randomized to receive daily 1 h yoga training ( $n = 411$ ) or physical exercise ( $n = 391$ ) for 2 months. Executive function, attention, and memory were studied using Trail Making Test (TMT). Yoga ( $n = 377$ )

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**Table 1: Mean and standard deviation of numerical Trail Making Test and alphabetical Trail Making Test for yoga and physical activity groups**

Group	TMTN			TMTA		
	Mean±SD					
	Pre	Post	pre post	Pre	Post	Δ pre-post
PA (n=391)	34.29±16.62	36.42±13.83***	-2.16±12.63	50.50±18.46	49.33±15.31	1.17±19.31
Yoga (n=411)	35.05±18.11	36.76±15.51*	-1.71±15.97	53.79±19.07	47.91±12.90***	5.87±19.16***

Within groups: \* $P \leq 0.05$ , \*\*\* $P \leq 0.001$ , Between groups: \*\*\* $P \leq 0.001$ . TMTA=Alphabetical Trail Making Test, TMTN=Numerical Trail Making Test, PA=Physical activity, SD=Standard deviation

and physical exercise ( $n = 371$ ) students contributed data to the analyses. The data were analyzed using intention-to-treat approach using Student's  $t$ -test.

## Results

There was a significant increase in numerical TMT (TMTN) values within yoga ( $t = -2.17$ ;  $P < 0.03$ ) and PA ( $t = -3.37$ ;  $P < 0.001$ ) groups following interventional period. However, there was no significant change in TMTN between yoga and PA groups ( $t = 0.44$ ;  $P = 0.66$ ). There was a significant increase in alphabetical TMT (TMTA) values within yoga group ( $t = 6.21$ ;  $P < 0.00$ ) but not in the PA group ( $t = 1.19$ ;  $P < 0.234$ ) following interventional period [Table 1]. However, there was a significant change in TMTA between yoga and PA groups ( $t = 3.46$ ;  $P = 0.001$ ).

The results suggest that yoga improves executive function, attention, and working memory as effectively as physical exercise intervention in adolescent schoolchildren.

## Discussion

Result from this two-armed randomized controlled trial is suggestive of equivalence between yoga practices and physical exercises with respect to visual scanning and cognitive processing and speed.<sup>[6]</sup> However, there was a significant improvement in executive functioning with yoga intervention compared to exercise. This study results differ from those of studies on yoga that have used small study populations.<sup>[4,7]</sup> Many other studies have found yoga practices to be more effective than physical exercises in many physiological functions such as in muscle control, balance, increased self-confidence, and other measures that are not studied in this trial.<sup>[8,9]</sup>

## Methods

While physical exercises may need large play area and close supervision to prevent injuries, yoga practices could be carried out in a confined area, with little support and supervision once the principles are understood. Furthermore, it is possible for students with disability (especially, visual) to practice yoga and gain confidence and stability in gait and other activities.<sup>[10]</sup> Further, for the elderly, yoga is a boon because sitting and lying down asanas could

be improvised to confer the same benefits as physical exercises.

## Conclusion

On the whole, though there are equal benefits of yoga and physical exercises seen in this study, the advantages of performing yoga cannot be overlooked.

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## Conflicts of interest

There are no conflicts of interest.

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